

MINERALS AND ROCKS

Introduction Minerals

- The earth is made up of different types of elements. To form minerals in the earth's crust, these elements are combined together.



IMAGE 7.1 : MINERALS

- Mineral is an inorganic element naturally occurring, with an ordered atomic structure, definite chemical composition and physical properties.
- The study of minerals is called mineralogy.
- Minerals are composed of two or three elements. But sometimes a single element mineral like Sulphur, Copper, Silver, Gold and Graphite, etc are also found.
- There are mainly six major mineral groups, with which most of the mineral groups are associated.
- The major mineral groups are Feldspar, Quartz, Pyroxene, Amphibole, Mica, Olivine etc.
- » The crust contains at least 2000 minerals.
- The hot magma in the earth's interior is the fundamental source of all minerals.
- Natural gas, petroleum and coal are organic minerals.
- Minerals present in the crust are in solid form, while they are in liquid form in the interior.
- 98% of the crust consist of eight elements:
 - Oxygen
 - Silicon
 - Aluminium
 - Iron
 - Calcium
 - Sodium
 - Potassium
 - Magnesium
- The rest is constituted by Hydrogen, Titanium, Phosphorous, Manganese, Sulphur, Carbon, Nickel & other elements.

The Major Elements of the earth's Crust

ELEMENTS	BY WEIGHT (%)
Oxygen	46.60
Silicon	27.72
Aluminium	8.13
Iron	5.00
Calcium	3.63
Sodium	2.83
Potassium	2.59
Magnesium	2.09
Others	1.41

Physical Characteristics of Minerals

- **External Crystal Form:** Depends on internal arrangement of molecules-cube, octahedrons, hexagonal, prisms.
- **Cleavage:** The tendency to break in specific directions to create relatively flat surfaces. It a result of internal arrangement of the molecule. The minerals may cleave in one or more directions and at any angle to each other.
- **Fracture:** Internal molecular arrangement are so complex that there are no planes of molecules; the crystal can split in an irregular way, not along cleavage planes.
- **Lustre:** Appearance of a material regardless of colour; each mineral has a distinctive lustre like metallic, silky, glossy etc.
- **Colour:** Characteristic colours determined by molecular structure. Ex: malachite, azurite, chalcopyrite some because of the impurities found the crystal.
- **Streak:** The color of every mineral powder. It may be the same colour or may vary as the mineral. Ex. Malachite-green, fluorite-purple/white.
- **Transparency:** Transparency means the degree to which a mineral can pass light through.
 - **Opaque:** The light is obstructed by the mineral and cannot pass through it.
 - **Translucent:** Light easily passes through the mineral, but is diffused so that it is difficult to clearly see images.

- **Transparent:** Light passes through the mineral and images can be seen clearly.
- **Structure:** Particular arrangement of the individual crystals: fine, medium, or coarse grained; fibrous separable divergent and radiating.
- **Hardness:** Relative resistance being scratched. Absolute hardness measured by a sclerometer. 10 minerals are selected to measure the degree of hardness from 1-10. They are: -Talc, Gypsum, Calcite, Fluorite, Apatite, Feldspar, Quartz, Topaz, Corundum and Diamond.
- **Specific Gravity:** It is the ratio of the weight of an object to the weight of an equivalent volume of water; the object was weighed in air and then weighed in water and the weight of the object in air was divided by the difference between the two weights.

Characteristics of Some of the Major Minerals

Feldspar

- Silicon and Oxygen are major elements in all types of feldspar.
- Potassium, sodium, Aluminium, calcium, etc are found in specific feldspar varieties.
- Nearly half of the earth's crust is composed of feldspar which is composed 39% of plagioclase and 12% of alkali feldspar.
- Its colour ranges from light cream to salmon pink.
- It is commonly used in glass making and ceramics.

Olivine

- The major elements of olivine are Magnesium, Iron and Silica.
- Olivine minerals primarily occur in mafic igneous rocks with a greenish colour.
- Olivine is used commonly in jewellery.



IMAGE 7.2: OLIVINE

Pyroxene

- The common elements in pyroxene are Aluminium, Calcium, Magnesium, Silicon and Iron.
- Nearly 10% of the earth's crust is made up of Pyroxene.
- It is commonly found in meteorites.
- Its colour is usually green or black.



IMAGE 7.4: PYROXENE

Quartz

- Quartz constitute one of the most important components of granite and sand.
- It consists of Silica which is hard mineral, almost insoluble in water.
- It is generally white or colourless.
- Quartz is mainly used in the manufacturing of radio, radar etc.



IMAGE 7.3: QUARTZ

Amphibole

- Calcium, Aluminium, Silicon, Magnesium and Iron are the major elements of amphiboles.
- Nearly 7% of the earth's crust is made up of amphibole.
- It is black or green in colour and is commonly used in asbestos industries.
- Hornblende is another form of amphiboles.



IMAGE 7.5: AMPHIBOLE

Mica

- It is made up of elements like Aluminium, potassium, Magnesium, Silicon, Iron, etc.
- Nearly 4% of the earth's crust is made up of Mica.
- It is generally found in metamorphic rocks and igneous.
- Mica is widely used in electronic instruments.

Types of Minerals

- **Metallic**
 - » Ferrous (containing Iron): Iron ore, Manganese, nickel, cobalt, etc.
 - » Non-ferrous: (does not contain Iron): Copper, lead, tin, bauxite, etc.
 - » Precious: Gold, silver, platinum, etc.
- **Non-metallic**
 - » Mica, salt, potash, Sulphur, granite, limestone, marble, sandstone, etc.
- **Energy Minerals**
 - » Coal, petroleum and natural gas
- **Metallic Minerals** are metals that are hard substance and conduct heat and electricity with characteristics of luster or shine. For example, Gold, Silver, Tin, Copper, Lead, Zinc, Iron, Nickel, Chromium and Aluminum.
- **Characteristics of Metallic Minerals**
 - » Metallic Minerals present a metallic shine in their appearance.
 - » Contains metals in their chemical composition.
 - » Potential source of the metal ores that can be extracted by way of mining.

- » Metallic minerals contain metal in raw form.
- » Metallic minerals are further classified into Ferrous (contains Iron) and Non-ferrous (does not contain Iron) metallic minerals.
- Non-metallic minerals are a specific group of chemical elements from which, if melted, no new product can be produced. For instance gravel, sand, gypsum, dimension stone, halite, Uranium,.
- Characteristics of Nonmetallic Mineral Resources:
 - » Nonmetallic minerals are minerals which are either present a non-metallic shine or luster in their appearance.
 - » These minerals do not contain extractable metals in their chemical composition.

Rocks Introduction

- A Rock is a solid, inorganic and natural substance without any specific atomic structure or chemical composition. It is easy to remember that rocks are made up of two or more minerals.
- Samples of rocks involve limestone, granite, marble, slate and sandstone. Each of this rock type consists of varied minerals that can be mixed up with the rock through different geologic processes.
- Let's consider granite. It mostly made up of three minerals namely: quartz, mica and feldspar.
- All of these minerals exist in nature but mixed up with the rock. Sometimes we see big chunks of one of these minerals in granite, but when we take that stone as a whole, we have to call it rock.



IMAGE 7.6: DIFFERENT TYPES OF ROCKS

Rocks in the Earth's Crust

- A rock is ultimately an aggregate or a physical mixture of various minerals.
- Rocks can be soft or hard and also vary in colors.
- Quartz and Feldspar are the most common minerals found in all types of rocks.
- Petrology is the science which deals with the study of rocks.
- » Rocks vary in their properties, particle size and forming mode. Rocks can be divided into three on the basis of the mode of formation:
 - » Igneous Rocks
 - » Sedimentary Rocks
 - » Metamorphic Rocks

Igneous Rocks

- The cooling of extremely fluid and hot liquid Magma forms Igneous rocks.
- Asthenosphere is a region below the Lithosphere and it is considered as the primary source of magma.
- Igneous rocks can be formed by two

types of processes:

1. Directly by cooling of magma in the interior of the earth.
 2. By cooling of lava above the surface of the earth when lava gets poured on the surface.
- As the Igneous Rocks form the earth's first crust and all other rocks are formed from these rocks, they are also known as the Primary Rocks or the parents of all rocks.
 - Igneous rocks are the most abundant rocks found in the crust of the earth.
 - On the basis of location of occurrence, these rocks can be classified as Intrusive and Extrusive Igneous Rocks.
 - **Intrusive Igneous Rocks**
 - » These are formed when magma cools and solidifies below the earth's surface.
 - » The rate of cooling below the surface of the earth is very slow, contributing to the development of large crystals in the rocks.
 - » That is why the mineral grains of intrusive igneous rocks are very large.
 - » Deep-seated intrusive igneous rocks are called Plutonic rocks and shallow depth intrusive igneous rocks are called Hypabyssal Rocks.
 - » E.g.: Granite, dolerite, etc.
 - **Extrusive Igneous Rocks**
 - » These are formed on the earth's surface by the cooling of the lava.
 - » The mineral crystals of extrusive igneous rocks are very fine as lava cools on the surface very rapidly.
 - » These rocks are also called Volcanic Rocks.
 - » Eg: Basalt, Gabbro.
 - On the basis of chemical properties, these are categorised as Basic and Acid Igneous rocks.

- They are formed because of solidification of basic lava (low viscous) or acidic (high viscous).
- Acidic igneous rocks contains 65% or more of Silica. They are dark coloured, hard and very strong (E.g.: Granite).
- Basic igneous rocks contain not more than 55% of Silica and have more Magnesium and Iron. They are dark in colour, weak enough and weathers easily (Eg: Basalt, Gabbro).



IMAGE 7.7: IGNEOUS ROCK FORMATIONS

Sedimentary Rocks

» Chemically formed Sedimentary Rocks

• **Mechanically formed/ Clastic Sedimentary Rocks**

- » They are formed under extreme pressure and cementation by the consolidation of sediments.
- » Eg: Conglomerate, Breccia, Sandstone, Shale, etc.

• **Organically/ Biologically formed Sedimentary Rocks**

- » These rocks are formed through the consolidation of organic matter derived from plants and animals.
- » E.g.: Coal, limestone, chalk, chert, etc.

• **Chemically formed Sedimentary Rocks**

- » They are formed by various chemical reactions.
- » Eg: Halite, Potash, Limestone, etc.

Sedimentary Rocks

- By successive deposition of sediments, these rocks are formed.
- These sediments are eroded from any previous existing rock like igneous, old sedimentary rocks or metamorphic.
- Lithification is called the process of successive deposition and formation of sedimentary rocks.
- They have a layered or stratified structure due to successive depositions and are hence often referred to as Stratified Rocks.
- Depending on the mode of formation, sedimentary rocks can be classified as:
 - » Mechanically formed/ Clastic Sedimentary Rocks
 - » Organically/ Biologically formed

Metamorphic Rocks

- The word metamorphic means 'change of form'.
- Hence, these rocks get formed under the action of temperature, volume changes and pressure on original form of rocks.
- Under the influence of pressure or heat on original rocks, metamorphic rocks are formed that cause their colour, hardness, structure and composition to change.
- Metamorphism is called the process of recrystallization and reorganisation of materials within the original rock.
- When metamorphism occurs without any major chemical alteration, it is referred to as Dynamic Metamorphism.

- If the impact of heat induces metamorphism, it is referred to as Thermal Metamorphism. It has two types: Regional Metamorphism and Contact Metamorphism.
- If the reorganisation happens when it comes into direct contact with the hot magma, it is called as Contact Metamorphism.
- If the rocks are metamorphosed due to tremendous pressure or heat and formed due to tectonic shearing, it is referred as Regional Metamorphism.
- On the basis of the presence or absence of bands of mineral grains Metamorphic Rocks can be classified into Foliated (Gneiss, Slate, Schist) and Non-Foliated (Marble, Quartzite) Metamorphic Rocks.



IMAGE 7.8: SCHIST, A TYPE OF METAMORPHIC ROCK

Rock Cycle

- Rocks do not remain for a long time in their original form, but can undergo transformations.
- The rock cycle is continuous process by which old rocks are turned into new ones. The rock cycle is shown in the following diagram.

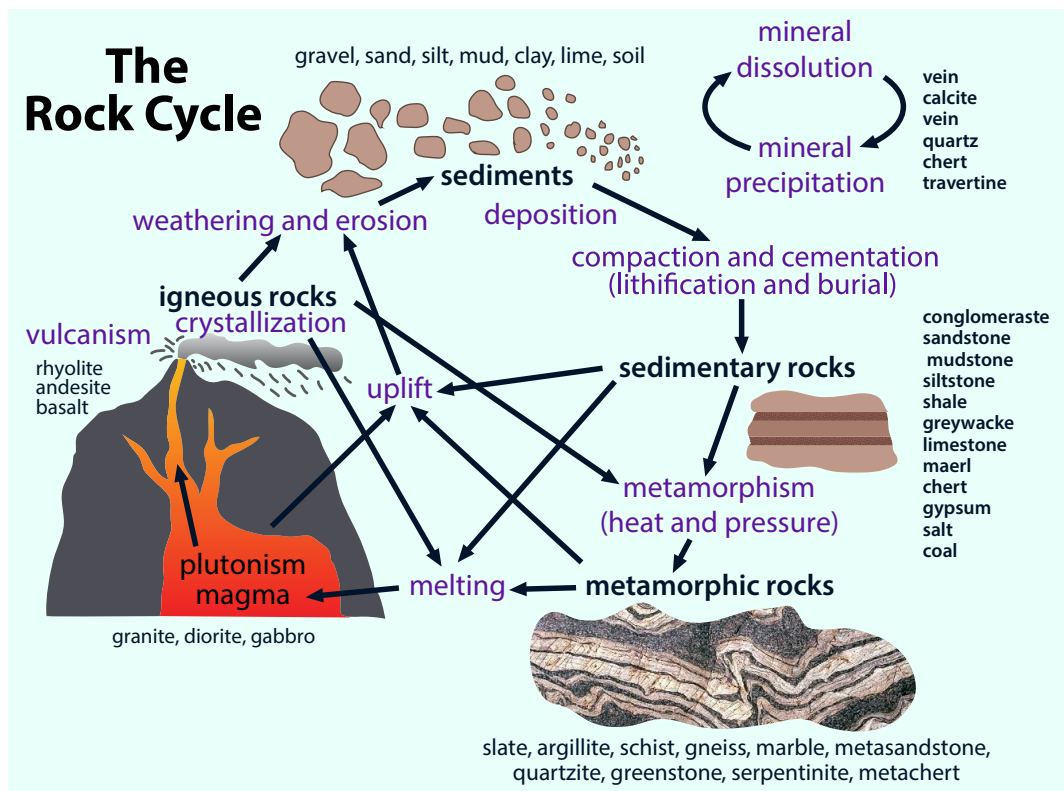


IMAGE 7.9: ROCK CYCLE.

Rock Vs Minerals

Rocks	Minerals
A rock is inorganic and solid naturally formed substance without any chemical composition or atomic structure.	A mineral is a solid, inorganic substance, like rocks, which has a definite chemical composition and crystalline structure.
Rocks comprise of minerals.	Minerals does not comprise of rocks.
Rocks exist in the tiny form which is also microscopic in nature.	Minerals are easily distinguishable in nature.
These occur in the solid form on the earth's crust.	Minerals are said to occur in the form of mineral deposits.
Rocks exhibit some physical properties like colour, texture, shape and pattern.	Minerals have very distinctive properties like shape, colour, texture, crystal habit, hardness, specific gravity, fracture, lustre and tenacity etc.
Some examples of rocks are sand, pebbles, shells, etc.	Few examples of minerals are Feldspar, Olivines, fossil fuels like coal, petroleum etc.
Rocks do not possess definite shape and are found in different colours.	Minerals are said to have definite shape and definite colour.